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REGIONAL GEOGRAPHY : A QUANTITATIVE APPROACH

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Regional geography is acknowledged to be complex, both in theory and practice, because numerous factors such as criteria, cores, and boundaries are involved (16). As there is a wealth of excellent geographic literature on regions and regionalism, it is not the purpose of this paper to attempt to add to regional theory, but, rather, to stress the contribution that the quantitative method can make to regional geography. At present, the scales are weighted in favor of the non-quantitative or descriptive method in academic training and professional interest. However, to ensure the continued growth of regional geography as a scholarly pursuit and to solve complex problems, it seens increasingly desirable to apply some of the statistical methods of analysis which have been made available over the last few decades. Or course, not every regional problem is amenable to the quantitative approach, and regional geography by its very nature will continue to profit from the other procedures which have long been employed.

Quantitative method and geography

Although there have been many written statements and oral assertions to the contrary, there is nothing in the nature of geography that militates against the use of quantitative analysis (11 and 25). For example, the following types of arguments have been advanced in explanation of why the statistical method is not well suited to geographic problems (1). The variables encountered in geography are too numerous to study (2). As geographic variables may be qualitative, quantitative, or both, they cannot be analyzed (3). Inasmuch as the geographer has no experimental control over his variables, as do research workers in some fields, the geographic variables cannot be individually examined (4). Geographic phenomena are normally considered in their spatial relationships, so the statistical approach is far less satisfactory than the use of maps (5). If statistical methods are to be used in geography, then new statistical systems must be designed to meet geography's specific problems. If the preceding statements were correct, then geographic research faces no future. Conversely, if the statements are basically wrong, then the quantitative method clearly has much to offer.

The first and second statement are false, because there are many available techniques for handling both quantitative and qualitative data (8, 10 and 11). One geographer has recently undertaken a research problem involving 50 variables ! The third statement is eloquently refuted by the following quotation : « It is not generally possible in economic and social analysis to eliminate all but one of the factors responsible for variation in a given series. The direct and indirect causes of a given social phenomenon are too numerous and too complicated in their interaction for the social scientist ever to hope to emulate the chemist in reducing his problem to terms of but two variables. But, within certain limits, the statistician is able to employ the method of the physical scientist in freeing a stated universe of the effects of changes in certain variables while the effects of variations in another are studied. The methods which make this possible are among the most powerful of the instruments that the student of the social sciences possesses (22). » The fourth statement is based upon a lack of knowledge of statistical methods. It also ignores the fact that a map is essentially a graph with every point located with reference to a grid system. All points on a map may then be coded and analysed (26). Although a map is an excellent tool for analysis, and especially for portrayal of data, it cannot supplant rigorous statistical methods in the study of spatial distributions. Statement five is false, because we are not even making full use of available quantitative methods. Of course, new and better techniques will always be desirable, but there is no gain in postponing research while waiting for better technique until present methods can be proven inadequate.

All geographers should be cognizant of the fact that the quantitative method has advanced considerably in many fields. In response to the needs of their disciplines, many university departments (eg. economics, sociology, psychology, biology) are now offering courses of statistics for their students, or else require formal training in the subject. There are, for example, college textbooks on statistics for economists, sociologists, psychologists, and so forth. Geographers can hardly expect to utilize the work of other fields, in which quantitative techniques are used, and pursue independent research without equivalent training.

The present status of the quantitative method, as applied to fields related to geography, is succinctly summarized in the following two quotations. « During the last two or three decades, the science of statistics has made available several powerful methods of analysis which find application in the physical, biological, and social sciences. Geology has not enlisted these methods so extensively as have some other sciences, but many of the techniques are peculiarly adaptable to geological problems (19). » « However, we make no all embracing claims for the quantitative as the only type of method useful and appropriate for social research. Our position is simply that quantitative methods are useful in the investigation of many sorts of sociological phenomena, and that when they are mastered more thoroughly by those engaged in sociological research, they will be extended to other areas which have not yet yielded to measurement (13). »

Computational problems

One very good reason why the quantitative approach has been used relatively infrequently in regional studies has been the laborious and exacting computations necessary in many analyses. Few people have been able to afford the time, or have had the necessary clerical help, to undertake research programs with involved computations, even with the aid of an electric desk calculator. This situation is now improving rapidly. During the past few years, high speed electronic computers capable of performing extremely rapid and complex calculations have become available to a rapidly growing number of personnel in universities, government, and business. This may prove to be a milestones for geographic research. It certainly necessitates a re-examination, if not a re-orientation, of our attitude towards research problems. This does not require any change in goals, but it does mean, very fortunately, that geographers now have much more effective tools than ever before to attain their goals. There is some urgency in the matter, because it takes times, measured in years, to translate the existing research potentialities made available by high speed computers into geographic thinking, teaching, and productive research. Already, geographers in some universities have made effective use of computers in a wide variety of geographic problems. An excellent illustration is the research at the University of Washington (Seattle) ; for example, a computer has been used by C. Hagen to study co-ordinates for azimuthal equidistant map projection tables ; by C. W. Wallace for lake density and muskrat catches in the Mackenzie Delta (N.W.T.) ; and by W. L. Garrison to analyse the benefits of rural roads to rural property. Several Canadian Universities have already purchased, or are soon to purchase, computers. The use of high speed computers does not, of course, eliminate the personal element in creating and planning research problems, but it does greatly expedite the computational portion, and makes possible the solution of many formerly unsolvable problems.

Some quantitative methods

The variety of statistical techniques is so great that little more can be achieved in the available space than to give a few illustrations of some of the more important methods that might be of use in regional studies. Additional bibliographical data may be found in Garrison (11) ; McCarty, Hook, and Knos (21) ; Reynolds (25) ; and Robinson and Bryson (26).

Multiple regression

Multiple regression provides one of the best methods of regional analysis if the influences of the separate variables can be added together. For instance, the yield of corn may be estimated upon the basis of mean monthly temperature and precipitation for the months of June, July and August. Multiple regression has been used in population studies (3), land form analysis, assessment of telephone traffic, and innumerable other research problems.

When one dependent and two independent variables are involved, their relationships may be determined graphically (24) or by computation. As the number of variables is increased, the computational problems multiply, so that few studies involving more than 5 or 6 variables are attempted manually, even with the use of a desk calculator. High speed computer programs capable of handling 10, 20, or more variables are available at computer centers, so that multiple regression analysis need no longer be restricted by computational difficulties to a few variables.

Methods of studying spatial distributions

Many methods are available to both supplement and complement maps in the study of spatial distributions. When discrete items (eg. farm houses) are involved, their distribution may be along a line or over an area — less frequently in three dimensional space. The items may be evenly or unevenly distributed ; if unevenly, they may be randomly or non-randomly distributed ; if non-randomly, they may be in positive or negative groupings. The distributional types just mentioned may all be analyzed and the results tested for significance. The Poisson formula may be applied readily to discrete items along a line or over an area in order to determine the type of distribution (5 and 9). The formula may also be used for points plotted on rectangular co-ordinates ; on equal-area paper (usually the Schmidt net, i.e. Lambert's azimuthal equal projection, equatorial case) ; and other diagrams (4 and 24). For example, the Poisson formula may be used to analyze the linear distribution of farm houses along a road or their areal distribution in a county. The significance of the results may be tested using chi-square. The method of reflexiveness if excellent (5) for studying groupings of discrete items — e.g. clusters of farms. The Poisson formula and theory of reflexiveness both complement those of other techniques well known from geographic writings, such as the evenness of distribution (30 and 35) and average spacings between objects (2).

Changes in spatial distributions are often shown by means of isopleth maps. The principle of slope (first derivative) analysis has been widely employed in landform studies (29) but perhaps the same general technique may be applied to isopleth lines as well. Possibly second derivative maps (15 and 32) might also be used on isopleth maps to « sharpen » the techniques of map analysis. When the regional analyst wishes to compare two spatial distributions, the data may, of course, be mapped and visually compared, but greater precision may be desired. For example, if distributional data is shown on isopleth or choropleth maps, the analyst may wish to determine just how closely the two maps correspond. One method is to superimpose two maps and then measure the areas common to paired class intervals. The resulting data may then be entered on a chart and the coefficient of correlation between the two series determined (23). The areal distribution of correlation coefficients may also be mapped (27). More elaborate methods of comparing areal distributions are given in a recent publication (26), and also in other methods (21).

Variance analysis provides a powerful tool for the examination of regional trends which may involve one, two, or even three factors. The method is covered in many standard works in statistics and there are numerous publications that illustrate its use in areal analysis (18).

The analysis of regions and regional boundaries

Factor analysis (principal components) has been used to subdivide areas into regions. « Factor analysis is a body of methods by which the relationships among a group of variables may be accounted for by a smaller number of variables, or common factors (13) ». Indices derived from factor analysis have been employed in regional delineation. For example, factor analysis has been used to subdivide the United States into regions based upon 104 items — 52 variables being in agriculture and 52 variables in population. Inasmuch as the group indices are statistically derived to give as homogeneous units as possible, the delimitation of the regions has an empirical basis. Factor analysis based upon so large a number as 104 items is beyond the reach of most workers, but the method may be used with a much smaller number of variables, such as five to ten. Variance analysis and the use of chi-square tests have also been used to delimit regions (36) as well as for the study of spatial distributions noted above.

The process of regional delimitation implies, of course, the existence of boundaries between regions ; if not boundaries, at least boundary zones. Discriminant analysis may be used for boundary studies, the method being succinctly explained as follows : « Assume that we have a set of measurements of a number of variables which are classified into two groups. Which linear combination of the various measurements will in a certain sense *best* discriminate between the two groups (21). » Let us assume that ten variables (eg. acreage in wheat, etc.) are associated with areas we specify as wheat farming (i.e. group one) and ranching (i.e. group two). Discriminant analysis provides a method of determining whether an area belongs more closely to the wheat or the ranching area, the criterion being based upon a linear combination of the variables under consideration. Thus discriminant analysis may be used to help formulate boundaries.

The relationship between regions may be « dynamic » rather than « static ». There is an ebb and flow of people, goods, services, etc., among various parts of the earth. The interactance hypothesis, or its numerous modifications, may be used to study many such dynamic relationships (1, 7, 14 and 20). The interactance hypothesis has been used to determine regional boundaries (12 and 17). It has been used in « potential » studies to analyse regional differences (28 and 33). Regression analysis has been extensively applied to assess regional differences.

Conclusion

Regional studies require both the qualitative and the quantitative approach. In some problems, a feeling and knowledge of the geographic milieu may be far more desirable than pages of rigorous analysis, whereas, in others, the reverse may be true. With the increasing availability of high speed electronic computers, the opportunities for research in regional studies are now vastly superior to any preceding period. This does not demand any change in geographic philosophy or goals. It does mean that we have more powerful techniques for attaining those goals. It also requires, as never before, a clear realization that the quantitative method should not be considered as an end in itself, but as a means towards an end. Although it would be undesirable for all geographers to specialize in quantitative methods, we should, in our college training programs, encourage those students who have aptitude for the quantitative approach to undertake such studies to the eventual enrichment of our field.

Bibliography

1. Ajo, R. (1953), *Contributions to « social physics »*, in *Lund studies in geography*, Ser. B. Human Geography No. 11, Royal University of Lund, Sweden, 27 pp.
2. Barnes, J. A., and Robinson, A. H. (1940), *A new method for the representation of dispersed rural population*, in *Geographical Review*, Vol. 30, pp. 134-137.
3. Bogue, D. J., and Harris, D. L. (1954), *Comparative population and urban research via multiple regression and covariance analysis.* Oxford, Ohio : Scripps Foundation for Research in Population Problems.
4. Chayes, F. (1946), *Application of the coefficient of correlation to fabric diagrams*, in *American Geophysical Union, Transactions*, Vol. 27, pp. 400-405.
5. Clark, P. J. (1956), *Grouping in spatial distributions*, in *Science*, Vol. 123, n° 3192, pp. 373-374.
6. Clarke, R. D. (1946), *An application of the Poisson distribution*, in *Journal Institute Actuaries*, Vol. 72, p. 481.
7. Dodd, S. C. (1950), *The interactance hypothesis : A gravity model fitting physical masses and human groups*, in *American Sociological Review*, Vol. 15, pp. 245-256.
8. Ezekiel, M. (1941), *Methods of correlation analysis.* Second Edition. New York : John Wiley and Sons, 531 pp.
9. Feller, W. (1957), *An introduction to probability theory and its applications*, Vol. I, Second Edition. New York : John Wiley and Sons, 461 pp.
10. Fisher, R. A. (1954), *Statistical methods for research workers.* 12th Edition. New York : Hofner Publishing Company.
11. Garrison, W. L. (1956), *Applicability of statistical inference to geographic research*, in *Geographical Review*, Vol. 46, pp. 427-429.
12. Green, H. L. (1952), *The reach of New York City and Boston into southern New England.* Ph. D. Dissertation, Harvard University, Cambridge, 175 pp.
13. Hagood, M. J., and Price, D. O. (1952) : *Statistics for sociologists.* Second Edition. New York : Henry Holt and Company, 575 pp.
14. Hammer, C., and Ikle, F. C. (1957), *Intercity telephone and airline traffic related to distance and the « Propensity to interact »*, in *Sociometry*, Vol. 20, pp. 306-316.
15. Henderson, R. G., and Zietz, I. (1949), *Computation of second vertical derivatives of geomagnetic fields*, in *Geophysics*, Vol. 14, pp. 508-516.
16. James, P. E., and Jones, C. F. (1954), *American Geography : Inventory and prospect.* Association of American Geographers, 590 pp.
17. Klove, R. C. (1952), *The definition of standard metropolitan areas*, in *Economic Geography*, Vol. 28, pp. 95-104.
18. Krumbein, W. C. (1955), *Statistical analysis of facies maps*, in *Journal Geology*, Vol. 63, pp. 452-470.
19. Krumbein, W. C., and Miller, R. L. (1953), *Design of experiments for statistical analysis of geological data*, in *Journal Geology*, Vol. 61, pp. 510-532.
20. Mackay, J. R. (1958), *The interaction hypothesis and boundaries in Canada : A preliminary study*, in *The Canadian Geographer* (in press).
21. McCarty, H. H., Hook, J. C., and Knos, D. S. (1956), *The measurement of association in industrial geography.* Department of Geography, State University of Geography, Iowa City, 143 pp.

22. MILLS, F. C. (1955), *Statistical methods.* Third Edition. New York : Henry Holt and Company, 842 pp.

23. MOWRER, E. W. (1938), *The isometric map as a technique of social research,* in *American Journal of Sociology*, Vol. 44, pp. 86-96.

24. PINCUS, H. J. (1953), *The analysis of aggregates of orientation data in the earth sciences,* in *Journal Geology*, Vol. 61, pp. 482-509.

25. REYNOLDS, R. B. (1956), *Statistical methods in geographical research,* in *Geographical Review,* Vol. 46, pp. 129-131.

26. ROBINSON, A. H., and BRYSON, R. A. (1957), *A method for describing quantitatively the correspondence of geographical distributions,* in *Annals Association American Geographers,* Vol. 47, pp. 379-391.

27. ROSE, J. K. (1936), *Corn yield and climate in the Corn Belt,* in *Geographical Review,* Vol. 26, pp. 88-102.

28. STEWART, J. Q. (1947), *Empirical mathematical rules concerning the distribution and equilibrium of population,* in *Geographical Review,* Vol. 37, pp. 461-485.

29. STRAHLER, A. N. (1956), *Quantitative slope analysis,* in *Bulletin Geological Society America,* Vol. 67, pp. 571-596.

30. THOMAS, C. R. (1944), *Some statistical methods in geographical interpretation.* Ph. D. Dissertation, University of Nebraska.

31. TINTNER, G. (1952), *Econometrics.* New York : John Wiley and Sons, 370 pp.

32. VACQUIER, V., STEENLAND, N. C., HENDERSON, R. G., and ZIETZ, I. (1951), *Interpretation of aeromagnetic maps,* in *Geological Society America,* Memoir 47, 151 pp.

33. WARNTZ, W. (1955), *A methodological consideration of some geographic aspects of the Newfoundland referendum on confederation with Canada, 1948,* in *The Canadian Geographer,* No. 6, pp. 39-49.

34. WAUGH, F. V. (1955), *Graphic analysis in economic research,* United States Department of Agriculture, Agricultural Handbook No. 84, 63 pp.

35. WRIGHT, J. K. (1937), *Some measures of distribution,* in *Annals Association American Geographers,* Vol. 27, pp. 177-211.

36. ZOBLER, L. (1957), *Statistical testing of regional boundaries,* in *Annals Association American Geographers,* Vol. 47, pp. 83-95.